

A NOTE ON THE GEOLOGY OF PANUARA AND ANGULLONG, SOUTH OF ORANGE, N.S.W.*

By N. C. STEVENS,
Geological and Mining Museum, Sydney.

(Three Text-figures.)

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Synopsis.

Mapping of this area links the Ordovician, Silurian and Devonian formations of Four Mile Creek and Cliefden Caves. Further details are given of the Ordovician Malongulli Formation and Angullong Tuff. Silurian strata ranging from Lower Llandovery to Wenlock, overlain by unfossiliferous shale and rhyolite, rest unconformably on Angullong Tuff. Upper Devonian Black Rock Sandstone overlies the rhyolite with unconformity. Monzonitic and syenitic rocks have invaded Ordovician strata south of Cadia, and flows of Tertiary trachyte and basalt are found at altitudes above 2000 feet.

1. INTRODUCTION.

Panuara and Angullong Estates are situated about 20 miles south-south-west of Orange and 15 miles west-north-west of Carcoar, between Panuara Rivulet and Cadiangullong Creek, south-flowing tributaries of the Belubula River. Panuara Estate has recently been subdivided for closer settlement, and the new roads and portions are shown on a map issued by the N.S.W. Department of Lands (1950).

The only reference to the geology of the district is a brief report by Booker (1950) on the Angullong Deep Lead. The map accompanying the report also shows Silurian sediments (including limestone near Cobbler's Creek) and Upper Devonian rocks to the west.

To the north, the geology of Four Mile Creek has been described by Stevens and Packham (1953), and a small area near the Cadia mines has been reported upon by Raggatt (1939). To the south and west, the country around Cliefden Caves and Cargo has been studied by the writer (Stevens, 1952; 1950). The present work clarifies the relations between Palaeozoic formations defined in papers on Cliefden Caves and Four Mile Creek.

2. STRATIGRAPHY.

Ordovician.

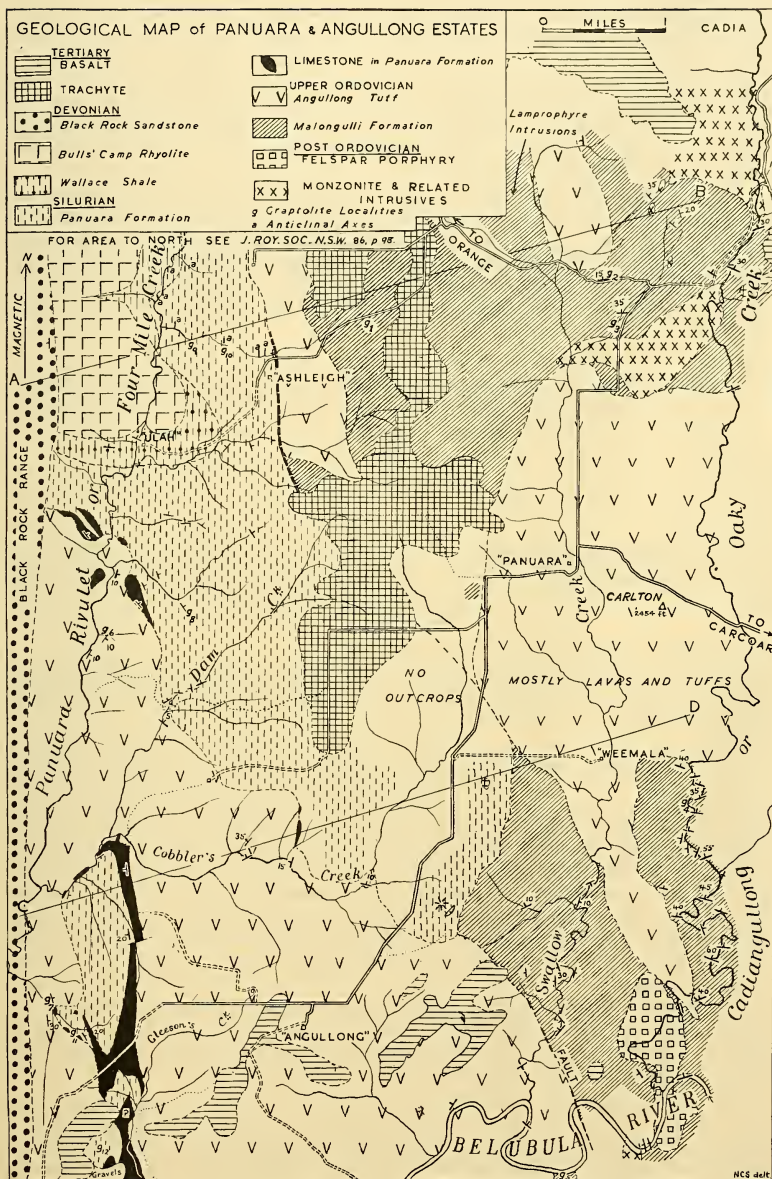
Of the four Ordovician formations of the Cliefden Caves district, only two, the Malongulli Formation and the Angullong Tuff, can be definitely recognized in the area shown on the map (Text-fig. 1). The limestone bed marked with a question mark in the south-western corner of the map may possibly represent the northernmost extension of the Cliefden Caves Limestone, but it adjoins Silurian limestone on the west and until more fossils are collected its age must remain in doubt.

Malongulli Formation.—This formation, originally defined in the Cliefden Caves paper (Stevens, 1952), was later recognized at Four Mile Creek (Stevens and Packham, 1953). It is now known to extend south to the Belubula River, and graptolites have been collected at five new localities.

The lithology of the formation is much the same as in the areas to the north and south, consisting mainly of thinly-bedded siltstone, black and often calcareous when fresh, and grey and slaty when weathered.

In the northern part of the area the following graptolites have been found: Locality g_1 , *Mesograptus foliaceus*, *Glyptograptus teretiusculus* (?) var. *euglyphus*; Locality g_2 , *G. teretiusculus*; Locality g_3 , *Diplograptus apiculatus* or *M. foliaceus*.

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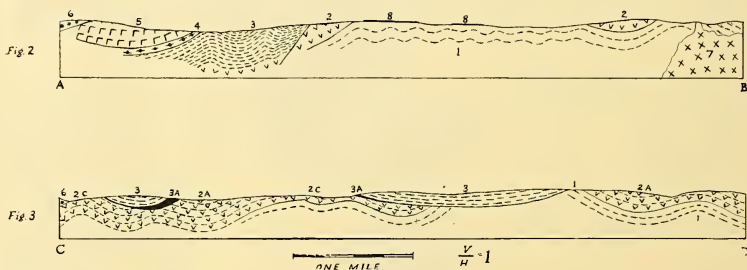


Text-fig. 1.—Geological Map of Panuara and Angullong Estates.

M. foliaceus (sensu stricto) is confined to zone 8 of the Ordovician (zone of *G. teretiusculus*), so that the strata at g_1 are one zone lower than the graptolite beds in the Malongulli Formation near Cliefden Caves. At g_3 structural evidence indicates a higher zone than zone 8, so that the graptolite is more likely to be *D. apiculatus*.

South-west of Cadia, cherts and some andesitic tuffs are interbedded with the siltstones near the top of the formation on either side of the belt of Angullong Tuff. To the west near "Ashleigh" (Text-fig. 1), the country is gently undulating with few outcrops, but good exposures of banded siltstones are to be seen to the south in Cadiangullong and Swallow Creeks.

The banded siltstones which outcrop in Swallow Creek east of Angullong are interbedded with andesitic tuffs and felspathic sandstones. The boundaries between fine and coarse sediments are irregular, and lenticular shale fragments are notable in some of the sandstones. These features are probably due to contemporaneous slumping and erosion of shaly beds. Some andesitic rocks are present in this area, but it is not clear whether they are part of the Malongulli Formation or the Angullong Tuff, as the strata are highly folded and faulted.



Text-fig. 2.—Geological Section A B across map.

Text-fig. 3.—Geological Section C D. 1, Malongulli Formation; 2, Angullong Tuff; 2A, Andesite; 2C, Conglomerate and breccia; 3, Panuara Formation; 3A, Bridge Creek Limestone; 4, Wallace Shale; 5, Bulls' Camp Rhyolite; 6, Black Rock Sandstone; 7, Monzonite; 8, Tertiary trachyte.

In Cadiangullong Creek most of the formation is made up of dark calcareous siltstones with occasional beds of felspathic sandstone and impure limestone. The siltstones exhibit regular bedding of dark fine-grained and coarser felspathic sediment. Near the top of the formation (at g_1) diplograptid graptolites, including a possible *Cryptograptus*, are associated with ostracods and fragments of trilobites and brachiopods. This part of the formation is probably not younger than Caradocian (zone of *Dicranograptus clingani*). To the south, near the confluence of Merrimalong Creek and the Belubula River (at g_3), *Glyptograptus* cf. *teretiusculus* has been found in dark grey siltstones which probably belong to the Malongulli Formation, although they are a little to the west of the main outcrop. This area is rather complex and has not yet been fully investigated.

Angullong Tuff.—The Angullong Tuff, which overlies the Malongulli Formation, outcrops over most of the southern part of the Panuara-Angullong area, as well as between "Ashleigh" and Cadia. The main rock types are andesitic tuffs, andesites, conglomerates, breccias and siltstones.

In the type area near Cliefden Caves the formation consists mainly of tuffs with some andesite flows, overlain by banded siltstones. At Four Mile Creek, where a sequence is difficult to establish, andesites are more prominent, and conglomerates and pebbly tuffs appear near the base of the formation. Between these two localities all these rock types are present.

On Panuara Rivulet and Cobbler's Creek, andesitic conglomerates and breccias with beds of dark siltstone and tuff underlie andesites. Similar rocks outcrop one mile north of "Panuara" and along the Belubula River south-east of Angullong, but their distribution is irregular.

Graptolites found in the siltstone beds at g_6 and g_7 include species of *Climacograptus* with thecae showing mesial flanges, indicating a zone near the top of the Ordovician. The siltstones are probably of the same zone as the graptolite-bearing siltstones on the Belubula River south of "Carlton" (Stevens, 1952).

Andesites, which apparently overlie the conglomerates, are found east and north of the Silurian limestone on Cobbler's Creek, and similar lavas, interbedded with tuffs and breccias, make up most of the formation around "Panuara" and "Ashleigh". Both augite- and hornblende-andesites have been noted.

In the Panuara-Angullong area and to the east, there are difficulties in distinguishing between andesites of the Angullong Tuff and the older Walli Andesite, and between siltstones of the Malongulli Formation and the siltstones in the Angullong Tuff.

Silurian.

Panuara Formation.—All the fossiliferous Silurian sediments of Four Mile Creek, ranging from Lower Llandovery to Upper Wenlock, are included in this formation. It extends south and south-east towards the upper part of Cobbler's Creek, and also occurs in an isolated basin resting uncomfortably on Angullong Tuff west of Angullong.

In the north-western part of the map, immediately south of the area mapped by Stevens and Packham (1953), the Panuara Formation is faulted against the Angullong Tuff and the basal limestone does not appear, but it outcrops two miles further south on either side of Panuara Rivulet. The limestone is more massive and not as fossiliferous as the Bridge Creek Limestone Member to the north, but *Favosites* and *Halysites* have been collected from the south-eastern outcrop. Another lens of limestone is found at the base of the Panuara Formation $1\frac{1}{2}$ miles north of Angullong. Nearer Panuara Rivulet, red, brown and green shales with some siltstones and fine-grained tuffs overlie the limestone.

Graptolites found in the shales at g_8 include *Monograptus flemingi* var. *primus*, *M. priodon* or *M. marri*, and (?) *Retiolites* sp. This association suggests a zone in the Lower Wenlock (g_3 of Four Mile Creek). In a west-flowing tributary of Panuara Rivulet near "Ashleigh", dark grey calcareous shales contain poorly-preserved graptolites at two localities (g_8 and g_{10}), probably the same horizon repeated by folding. The graptolites are *Monograptus* cf. *variabilis* or *nudus*, indicating an Upper Llandovery age, but structure and lithology suggest a higher zone.

South-east of Dam Creek, outcrops of the Panuara Formation are infrequent, and the lithology changes from shales to micaceous sandstones and siltstones. East of the Angullong Road these resemble sediments of the adjoining Malongulli Formation.

In the basin of Silurian sediments west of Angullong, limestone again occurs at the base of the Panuara Formation and outcrops along the eastern, southern and northern sides of the basin. On the south-western side, two limestone beds are separated by about 250 feet of brown and grey shales and siltstones. A bed of conglomerate, eight to 10 feet thick, with andesite boulders, underlies the upper limestone.

The lower limestone bed is similar to the Bridge Creek Limestone. Fossils found in it include *Halysites* (two species), *Heliolites*, *Favosites*, Mycophyllids, Streptelasmids, Pentamerids and bryozoa. Colonies of *Eofletcheria* "very like *subparallela*" (according to Dr. Hill) are notable. This coral has been described from the zone of *Dicranograptus clingani* in Norway (Hill, 1953), but in this district there is evidence that it is of Lower Llandovery age.

Graptolites have been found at three localities in the overlying shales. From the lowest locality (g_{11}) Mrs. Sherrard identified *Monograptus intermedius*, *M. triangulatus* and (?) *Rastrites longispinus*. Later a more comprehensive collection was obtained,